4.3 GEOLOGY, SOILS, PALEONTOLOGY, AND MINERAL RESOURCES

4.3.1 Environmental Setting

Information for this section was obtained in part from the *Geotechnical Engineering Report, Proposed 24-Inch Diameter PG&E 108 Gas Line Extension*, Thornton to Elk Grove, California (PG&E 2006a) and the *Paleontologic Resource Assessment, Impacts and Mitigation for the PG&E Line 108 Project* (PG&E 2006b).

Regional Geology

The Project area is located in the Great Valley province, a northwest-trending asymmetrical structural basin bounded by the Sierra Nevada province to the east and south, the Klamath Mountains to the north, the Cascade Range province to the northeast, and the Coast Ranges province to the west. The Great Valley is comprised of the Sacramento Valley and the San Joaquin Valley and is a nearly flat alluvial plain extending for about 450 miles from the Klamath Mountains south to the Tehachapi Mountains.

The proposed pipeline route would be located south of the cities of Sacramento and Elk Grove in Sacramento and San Joaquin Counties, east of the Sacramento River. The Great Valley geomorphic province is a basin separating Sierra Nevada granitic rock from the marine and non-marine sedimentary rock of the California Coast Ranges. Sediment deposits within the area accumulated in a marine environment from approximately 25 million to 175 million years ago.

The proposed pipeline route would also pass through a small portion of the Sacramento-San Joaquin Delta (Delta). Since late in the Quaternary, the Delta has experienced cycles of deposition, non-deposition, and erosion, resulting in the accumulation of a few hundred feet of poorly consolidated to unconsolidated overlying sediments. Cycles of erosion and deposition also resulted in the formation of a complex pattern of islands and interconnected sloughs, as the Sacramento, Mokelumne, and San Joaquin Rivers entered from the north, northeast, and southeast and finally merged in the Delta. River and slough channels were repeatedly incised and backfilled with sediments from fluctuations in river flows. These processes were further complicated by concurrent subsidence and tectonic changes in the land surface.

Local Geology

The proposed pipeline route consists of relatively flat, level topography along major transportation routes and in areas of agricultural land use and conservation land. Existing grades from road and railroad structures extend above the level agricultural fields.

The Project area is underlain by Quaternary alluvial deposits consisting of channel and basin deposits. Additionally, in the vicinity of the Sacramento, San Joaquin, and Mokelumne Rivers, man-made levees have been constructed for flood control purposes.

Regional Faulting

The Project area lies within Seismic Zone 3 (CBSC 2001) and is not located within an Alquist-Priolo Earthquake Fault Zone. No active fault zones or shear zones are known to cross the proposed pipeline route. As shown in Table 4.3-1 and illustrated in Figure 4.3-1, the nearest active fault that is well mapped is the Great Valley Fault System (segment 5) which lies approximately 21 miles to the southwest of the Project area and the Foothills Fault System approximately 24 miles to the east (east of the coverage of Figure 4.3-1). These faults have been identified as the most probable earthquake faults that could result in ground acceleration in the Project area with corresponding magnitudes presented in Table 4.3-1. In addition to active faults, there are several pre-Quaternary faults in the Project area that are not considered active. Although the proposed pipeline would not be located within an Alquist-Priolo Fault zone or any known shear zones, the potential for strong seismic-related ground shaking exists from nearby active faults. In order for a fault to be considered "active," it must have experienced seismic activity during the last 11,000 years.

The Project vicinity is generally characterized by low to moderate seismic activity. Historical information indicates that the proposed pipeline route could be subject to strong seismic ground shaking during the design life of the Project.

Soils

Field explorations of drilling and sampling were conducted in 19 test borings extending to a depth of approximately 101 feet below ground surface (bgs) along the proposed pipeline route (PG&E 2006a). The explorations documented a thickness of fill material up to approximately seven feet bgs within four borings, primarily consisting of native

Figure 4.3-1*. Regional Fault Map. Placeholder. 11x17 color. (page 1 of 2)*

Table 4.3-1. Maximum Earthquake Magnitudes from Nearby Seismic Events

Fault Name	Closest Distance to Alignment (approx. miles)	Magnitude of Maximum Earthquake
Foothills Fault System	24 to 28	6.5
Great Valley – Segment 3	35 to 39	6.9
Great Valley – Segment 4	24 to 25	6.6
Great Valley – Segment 5	21 to 25	6.5
Great Valley – Segment 6	24 to 30	Deleted by the CGS/USGS
Great Valley – Segment 7	36	6.7

Note: The assigned Maximum Earthquake Magnitudes are based on a California Geological Survey (CGS)/United States Geological Survey (USGS) 2002 probabilistic model for earthquakes in California. The reported magnitudes are Maximum Moment Magnitudes rather than Richter Scale Magnitudes which is now considered obsolete. As indicated in the table, the Great Valley fault - Segment 6 was deleted from the CGS/USGS database as recent investigations showed that the fault is not a significant seismic source.
Source: CGS 2002.

materials that were moved around to create access roads for the farm properties. Thicker fills are likely present in the aforementioned levees along the rivers in the Project area. On the whole, the entire proposed pipeline route is underlain by native alluvial river deposits consisting of silty sands, poorly graded sands, sandy silts, and clays.

Soil Instability

Liquefaction

Liquefaction is a phenomenon in which saturated, cohesionless soils temporarily lose their strength and liquefy when subjected to dynamic forces such as intense and prolonged ground shaking. Liquefaction typically occurs when the water table is less than 50 feet bgs and the soils are predominantly unconsolidated. The potential for liquefaction increases as the groundwater approaches the surface. Based on the depth to groundwater in the Project area, ranging from nine to more than 50 feet below ground surface, and the low to moderate seismicity potential in the region, liquefaction is possible along the proposed pipeline route.

The State of California has not yet mapped the region that the proposed Project would be located in for Seismic Hazard Zones for liquefaction or seismic slope stability. Based on liquefaction analysis, the potential for liquefaction is considered “low” for the portion of the Project north of Twin Cities Road, due to the lack of groundwater and the relative densities of the soils encountered in borings (PG&E 2006a). However, because groundwater was found between nine and 35 feet bgs, the potential for liquefaction in the portion of the Project south of Twin Cities Road is considered “low” to “moderate.”

Seepage

Uncontrolled seepage through an embankment such as a levee can result in erosion and ultimately failure of the embankment.

Erosion

Erodibility is the measure of the susceptibility of soil particles to detach and transport by rainfall, runoff, and/or wind. Erosion hazards are generally accelerated with soil disturbance and exposure to sun, wind, and/or water. U.S. Department of Agriculture Soil Conservation Service Soil Survey erosion hazard ratings for soils along the proposed pipeline route range from none to negligible for wind- and water-related erosion (USDOA 1954).

Mineral Resources

The majority of the proposed pipeline route lies within Sacramento County where mineral resources include natural gas, sand, gravel, petroleum, clay, gold, silver, peat, topsoil and lignite (Sacramento County 1993). Numerous sand and gravel aggregate production areas are present in Sacramento County and along with natural gas represent the primary resources that are actively extruded (Sacramento County 1993). The larger aggregate production areas are located outside the vicinity of the Project area in the Fair Oaks and Perkins-Kiefer areas. The majority of the natural gas production areas are located in the Delta’s Rio Vista Field, also outside of the Project area.

San Joaquin County, in conjunction with the State Mining and Geology Board, has developed “Significant Sand and Gravel Aggregate Resource Sectors.” Most of the aggregate resource sectors are located far from the Project site. Alluvial fans and terrace deposits located along the western edge of the Delta have been identified as potential aggregate sources. The southern portion of the Project area is located above the abandoned Thornton gas field (San Joaquin County 1992).

Paleontological Resources

The Project site is directly underlain by Quaternary sedimentary deposits assigned to the late Pleistocene Riverbank Formation throughout all but the southernmost segment (about one mile) of the proposed pipeline route, where it traverses younger channel, natural levee, and basin deposits of the Cosumnes and Mokelumne Rivers. Detailed paleontologic investigations of subsurface geologic units which may exist at depth below the Project site have not been conducted; therefore, it is unknown which units are present and whether they would be affected by Project activities.

However, subsurface geologic units which may exist below those exposed at the surface include the Valley Springs, Mehrten, and Laguna Formations, all of which are known to contain significant fossils within the geographic extent of their surface expression. A review of locality records at the University of California (Berkeley) Museum of Paleontology (UCMP) and at Sierra College revealed 25 known vertebrate fossil localities of Pleistocene age in San Joaquin and Sacramento Counties, though only nine of these, all of which are located in Sacramento County, could be definitely assigned to the Riverbank Formation. Most Pleistocene localities in central California were found in manmade excavations rather than exposures created by natural erosion: deep soils and vegetation cover obscure the fossil-bearing sediments in areas of moderate to high precipitation.

No Riverbank Formation vertebrate fossils are known in San Joaquin County, but UCMP records indicate additional Riverbank Formation localities in Fresno, Merced, Stanislaus, and Madera Counties. The largest assemblage of vertebrate fossils known from the Riverbank Formation occurs about 100 miles south of the Project site in Madera County. This assemblage was recovered from the Fairmead Landfill locality (UCMP loc. V93128) (PG&E 2006b), but this site appears to be in a much older portion of the formation than that represented in the area of the proposed Project. At the deeply excavated Fairmead Landfill locality, both the geologic setting and the fossil assemblage recovered and analyzed to date indicate that it was deposited during the Irvingtonian Land Mammal Age which ended approximately 400,000 years ago (PG&E 2006b). The next younger period, known as the Rancholabrean Land Mammal Age, is characterized by the presence of Bison (North American “buffalo”), which has not been found at the Fairmead site but is known from both the Arco Arena and Teichart sites (see below) that are much closer to the Project site and presumably more similar in age.

An important Riverbank Formation locality exists at the site of the Arco Arena, just west of the City of Sacramento and 17 miles north-northwest of the Project site. More than 100 fossils representing giant ground sloth, extinct giant bison, coyote, horse, camel, squirrel, antelope or deer, and mammoth were recovered from the excavation. The fossils were recovered from overbank deposits in the Riverbank Formation that range from pebble- to clay-sized fluvial sediment about 13 to 30 feet below the surface (PG&E 2006b).

Abundant vertebrate fossils have also been found ten miles northeast of the Project site at the Teichart Gravel Pit, in the southern part of Sacramento (UCMP localities V 69129 and V 75126), primarily in channel and near-channel deposits within the Riverbank Formation. This assemblage of 33 recorded specimens includes four that represent single species each of fish, bird, and snake. Identified mammals include mole, packrat, gopher, coyote, dire wolf, horse, bison, camel, giant ground sloth, and mammoth. A portion of a mammoth pelvis was recovered from another locality (V 74086) about 4 miles northeast of the Project site. UCMP records also document two closely spaced Riverbank Formation localities (V 68046, V 68141) in the City of Sacramento, about 12 miles north-northeast of the Project site. These yielded a mammoth skull and other bones as well as a partial pelvis and hind limb bones of an extinct horse.

A locality 12 miles east of the Project site is recorded in the UCMP vertebrate locality catalog (V 3524), but no specimen is listed. The locality falls within the area of mapped Riverbank Formation and although the specimen may have been lost, the existence of the record indicates that a vertebrate fossil was found at this locality.

The Bilby Road locality noted in the Sierra College records lies very close to the Project site, east of the town of Franklin. A partial skull, ribs, and foot bones that belonged to a mammoth were recovered from an excavation for a construction project in 2004. The specimen was found in a sandy lens in tan clay.

Another locality which yielded parts of a mammoth skeleton was reported by three local residents of the nearby town of Herald. Pinpointed on a map by one of the residents, the locality is about five miles east of the proposed Project site in an area mapped as Riverbank Formation (PG&E 2006b).

4.3.2 Regulatory Setting

Geology and Soils

Federal

The U.S. Department of Transportation (DOT) establishes the “Transportation of Natural Gas by Pipeline: Minimum Federal Safety Standards” as required in 49 Code of Federal Regulations (CFR) 192. Regulations specific to geological hazards and soil conditions are stated in 49 CFR Chapter I, Section 192.317(a) as follows: ”The operator must take all practicable steps to each transmission line or main from washouts, floods, unstable soil, landslides, or other hazards that may cause the pipeline to move or to sustain abnormal loads.”

The Federal Water Pollution Control Act of 1972 and Clean Water Act of 1977 require that discharge requirements be met, including the discharge of sediment to surface water as a result of erosion. The Soil Conservation Service (SCS) National Engineering Handbook presents standards for planning, design, and construction of soil conservation practices to be implemented during construction projects.

State

The Alquist-Priolo Special Studies Zones Act was enacted in 1972 and in 1994 it was renamed the Alquist-Priolo Earthquake Fault Zoning Act (APEFZA). The primary purpose of the APEFZA is to mitigate the hazard of fault rupture by prohibiting the location of structures for human occupancy across the trace of an active fault (Hart and Bryant 1997). The APEFZA requires that “earthquake fault zones” be delineated by the State Geologist along faults that are “sufficiently active” and “well defined.” These faults show evidence of Holocene surface displacement along one or more of their segments and are clearly detectable by a trained geologist as a physical feature at or just below the ground surface. The boundary of an earthquake fault zone is generally about 500 feet from major active faults, and from 200 to 300 feet from well-defined minor faults. The APEFZA dictates that cities and counties withhold development permits for sites within an earthquake fault zone under their jurisdiction until geologic investigations demonstrate that the sites are not threatened by surface displacements from future faulting (Hart and Bryant 1997).

The Seismic Hazards Mapping Act of 1990 (California Public Resources Code (PRC) Section 2690 and following as Division 2, Chapter 7.8), as supported by the Seismic Hazards Mapping Regulations (CCR Title 14, Division 2, Chapter 8, Article 10), were promulgated for the purpose of protecting public safety from the effects of strong ground shaking, liquefaction, landslides, other ground failures, or other hazards caused by earthquakes. Special Publication 117, Guidelines for Evaluating and Mitigating Seismic Hazards in California (CDMG 1997), constitutes the guidelines for evaluating seismic hazards other than surface fault rupture, and for recommending mitigation measures as required by PRC Section 2695(a).

The major State regulations protecting the public from geo-seismic hazards, other than surface faulting, are contained in California Code of Regulations, Title 24, Part 2, the

California Building Code (CBC), the California Plumbing Code (CPC), and California PRC, Division 2, Chapter 7.8, the Seismic Hazards Mapping Act. The CBC is based on the Uniform Building Code (UBC), which is used widely throughout the United States (adopted on a state-by-state or district-by-district basis) and has been modified for California conditions with numerous more detailed and/or more stringent regulations.

Chapter 33 of the CBC regulates grading activities, including drainage and erosion control, and construction on expansive soils. Construction activities are subject to occupational safety standards for excavation, shoring, and trenching as specified in Cal-Occupational Safety and Health Administration (OSHA) regulations (Title 8 of the California Code of Regulations [CCR] and in section A33 of the CBC). These regulations specify the measures to be used for trench work where workers could be exposed to unstable soil conditions. Shoring the sides of trenches is the primary method used to prevent caving of soils into trenches. PG&E would be required to employ these safety measures during construction of the proposed pipeline. There are no applicable building codes for buried pipeline design or operation.

Local

<u>Sacramento County</u>

The Sacramento County Department of Water Resources has requirements for controlling erosion at construction sites in the county. Applicants of construction projects disturbing one acre or more, or moving 350 cubic yards or more of soil, are required to obtain a grading permit and comply with the provisions of the county's Land Grading and Erosion Control Ordinance (SCDWS 2007).

<u>San Joaquin County</u>

San Joaquin County Pubic Works Department requires developers in the county to submit and implement a program to control the pollution of storm water discharges from construction sites (SJCPWD 2007).

Mineral Resources

State

The primary State law concerning conservation and development of mineral resources is the California Surface Mining and Reclamation Act (SMARA) of 1975, as amended to date. SMARA is found in the PRC, Division 2, Chapter 9, Sections 2710, *et seq*.

Depending on the region, natural resources can include geologic deposits of valuable minerals used in manufacturing processes and the production of construction materials. SMARA was enacted in 1975 to limit new development in areas with significant mineral deposits. SMARA calls for the State geologist to classify the lands within California based on mineral resource availability. In addition, the California Health and Safety Code requires the covering, filling, or fencing of abandoned shafts, pits, and excavations (California Health and Safety Code Sections 24400-03.). Furthermore, mining may also be regulated by local government, which has the authority to prohibit mining pursuant to its general plan and local zoning laws.

Local

<u>Sacramento County</u>

The Sacramento County General Plan has outlined several objectives and policies within the conservation element to protect mineral resources of the county. The following objective and policy was considered as part of this analysis:

- Objective: Known mineral resources protected from land uses which would preclude or inhibit timely mineral extraction to meet market demand.

- Policy CO-42: Sewer interceptor and trunk alignments shall be routed to avoid areas planned for aggregate resource mining to the extent practical. Where such alignments are impractical, they shall be designed to minimize aggregate resources which would be precluded from mining, and make reasonable attempt to preserve the future use of mined areas for flood control or recharge purposes.

<u>San Joaquin County</u>

The San Joaquin County General Plan also has a policy that protects mineral resources of the county. The following policy was considered as part of this analysis:

- Policy: To protect extractive resources from urban development or encroachment.

Paleontological Resources

Conservation of paleontologic resources in the state of California is mandated by the California Environmental Quality Act (CEQA) and by the Archeological, Paleontological, and Historic Sites sections of the PRC. Federal statutes relating to protection of paleontologic resources include the Federal Land Policy and Management Act, Antiquities Act of 1906, and the National Environmental Policy Act of 1969.

4.3.3 Significance Criteria

Geology and Soils

An adverse impact on geology and soils is considered significant and would require mitigation if:

- Settlement of the soil could substantially damage structural components;
- Ground motion due to a seismic event or any resulting phenomenon such as liquefaction or settlement could substantially damage structural components;
- Rupture of a known earthquake fault as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map could expose people or structures to potential adverse effects;
- Damage resulting from any of the above conditions could result in an inadvertent or uncontrolled release of hazardous, harmful or damaging substances into the environment;
- Result in substantial soil erosion or the loss of topsoil;
- Erosion rates would be increased, or soil productivity would be reduced by compaction or soil mixing, to a level that would prevent successful rehabilitation and eventual reestablishment of vegetative cover to the recommended or pre-construction composition and density;
- Agricultural productivity would be reduced for longer than three years[1] because of soil mixing, structural damage, or compaction; or
- Any Project activity or condition has a chance of adversely affecting the stability or proper functioning of any levee or levee system.

Mineral Resources

An adverse impact on mineral resources is considered significant and would require mitigation if it would:

- Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the State.

[1] Three years is a conservative interval beyond which an impact to agricultural productivity would not be considered temporary.

- Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan.

Paleontologic Resources

Paleontologic resources are fossilized evidence of past life found in the geologic record. Despite the prodigious volume of sedimentary rock deposits preserved worldwide and the enormous number of organisms that have lived through time, preservation of plant or animal remains as fossils is an extremely rare occurrence. Because of the infrequency of fossil preservation, fossils (particularly vertebrate fossils) are considered to be nonrenewable resources. Because of their rarity and the scientific information they can provide, fossils are highly significant records of ancient life. As such, paleontological resources may be considered "historically significant" in the scientific annals of California under CEQA Guidelines Section 15064.5[3]. An impact to an identified paleontologic resource is considered "historically significant" and would require mitigation if:

- Project construction or operation would result in damage or loss of vertebrate or invertebrate fossils that are considered important by paleontologists and land management agency staff; or
- The resource is considered to have scientific or educational value. A paleontological resource can be considered to have scientific or educational value if it:
    - provides important information on the evolutionary trends among organisms, relating living inhabitants of the earth to extinct organisms;
    - provides important information regarding development of biological communities or the interaction between botanical and zoological biota;
    - demonstrates unusual or spectacular circumstances in the history of life;
    - is in short supply and in danger of being depleted or destroyed by the elements, vandalism, or commercial exploitation and is not found in other geographic locations;
    - is recognized as a natural aspect of our national heritage;
    - lived prior to the Holocene (~11,000 B.P.); and
    - is not associated with an archaeological resource, as defined in Section 3(1) of the Archaeological Resources Protection Act of 1979 (16 USC § 470bb[1]).

4.3.4 Impact Analysis and Mitigation

Applicant Proposed Measures (APMs) have been identified by PG&E in its Environmental Analysis prepared for the CSLC. APMs that are relevant to this section are presented below. This impact analysis assumes that all APMs would be implemented as defined below. Additional mitigation measures are recommended in this section if it is determined that APMs do not fully mitigate the impacts for which they are presented.

APM GEO-1. Bridge Removal Work Plan. A registered engineer shall prepare a detailed work plan for the removal of the bridge abutment on the north side of the river to insure bank stability for all construction activity occurring near the river bank. The bridge removal work plan will be submitted to the CSLC for review and approval at least 60 days prior to mobilizing equipment to the site.

APM GEO-2. Drilling Plan. PG&E shall develop a site specific drilling plan that will maximize the probability of a successful river drill. The plan will address the soil conditions documented in the Geotechnical Report developed by Terracon. PG&E shall provide a qualified HDD inspector during Project excavation and drilling to confirm and identify site-specific soil conditions along the entire route of the pipeline. Should unstable soil conditions be identified, PG&E shall conform to recommendations provided by the HDD inspector. The drilling plan will be submitted to the CSLC for review and approval at least 60 days prior to mobilizing equipment to the site.

APM GEO-3. Drilling Programs.

Mitigation of Adverse Drilling Conditions:

- The HDD drilling contractor shall prepare a drilling program specifically designed for the site soil conditions. This program shall include, but be not limited to, buoyancy control measures, if required; drilling mud weight calculations, drilling fluid pressure, any additives the subcontractor may need to employ, including additives to increase gel and filter cake strength, inhibit swelling, and reduce stickiness. Possible loss of circulation materials and grouting materials shall also be included in the plan.

Recommended Drilling Depth:

- PG&E shall hire a State certified hydrogeologist to conduct a scour analysis and report of the pipeline crossing at the Cosumnes and Mokelumne Rivers. The scour analysis shall present the overall depth of each river.

- The depth of the bore beneath the toe of the levee and the bottom of the Cosumnes and Mokelumne Rivers shall be designed to be at least 20 feet[2] below the scour depth identified in the scour analysis report, with a minimum of 35 feet below the lowest point of the bottom of the river, as directed above.

Inspection and Monitoring:

- The HDD inspection personnel shall have the authority to stop the boring operations if it appears as though damage is occurring to any above ground appurtenances.

- A pressure while drilling (PWD) tool[3] shall be utilized during the HDD.

- The drilling contractor shall develop a Drilling Fluid Program as part of the HDD Bore Plan, which shall take into account anticipated soil conditions, fluid selection, drill bit and reamer selection, and volume calculations. This plan will be submitted by PG&E to the CSLC for review and approval, and shall be maintained on site during drilling activities.

- An Inadvertent Release Plan shall be provided and will include provisions for spill cleanup materials. This plan will be submitted by PG&E to the CSLC for review and approval, and shall be maintained on site during drilling activities.

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[2] The 20-foot depth requirement below the anticipated scour depth is an industry accepted standard. This depth provides an adequate factor of safety to ensure that the pipeline will not become exposed or be subjected to suspended sediments traveling in bed load during peak flows.

[3] The PWD measures down-hole annular pressure, internal pressure, and temperature in real time. The sensor reduces the risk of unexpected fracture or collapse. Because the sensor is making its measurements down-hole, the PWD makes it possible to detect pressure drops earlier then more traditional surface measurements.

Drilling Fluid Selection:

- A Drilling Fluid Program Base Fluid shall be designed for site-specific soil conditions. The base fluid may consist of either a bentonite or polymer base and water with additives to achieve specific fluid properties; however, additives that are considered toxic to wildlife will not be allowed.

- In reactive soils the use of partially hydrolyzed polyacrylamide polymers to inhibit swelling and wetting agents to reduce stickiness may prove beneficial. Additives may be needed to treat make-up water[4] containing excess amounts of calcium or chlorine. Salt (chloride) is detrimental to base fluid performance and shall not be present in make-up water.

- The drilling contractor shall submit a base fluid design with a list of additives, loss of circulation materials, and grouting materials that may be used on the Project and material safety data sheets to CSLC for approval at least 60 days prior to mobilization.

- The drilling fluid program, including the base fluid design, manufacturer's specifications and material safety data sheets will be submitted to the CSLC at least 60 days prior to mobilizing equipment to the site for review and approval.

Drill Bit and Reamer Selection:

- Drill bits and reamers shall be based on anticipated subsurface conditions and past experience.

- The use of mud motors shall be considered in cemented soil with Standard Penetration Test blow counts exceeding 60 blows per foot.

APM PAL-1. Paleontology Mitigation Program. At least 90 days prior to the first planned target date for beginning of the excavation phase of the Project, PG&E shall hire an experienced vertebrate paleontologist with geologic knowledge of the Line 108 site to develop and supervise a mitigation

[4] Make-up water is water that is added throughout the drilling process. This additional water is necessary because the hole is getting longer and drill tailings are being removed on recirculation.

program. This person shall also have knowledge of and experience in recognition of fossils at construction sites and field techniques in vertebrate paleontology, and shall be contracted to monitor construction-related excavation. Only one monitor shall be present on site during all qualifying excavations.

Arrangements shall be made in advance of commencement of construction for two individuals to be on-call to assist in the salvage of large specimens or fossil concentrations should they be encountered during the excavation phase.

Based on the land status of all parcels within the Project area the paleontologist will contact each jurisdiction having land use authority to determine any statutory requirements relating to disturbance of paleontologic resources throughout the Project area and obtain any necessary permits and clearances.

The paleontologist shall conduct preliminary discussions with potential repository institution(s) (qualified institution maintaining paleontological research collections) before commencement of construction to determine their needs and requirements for permanent conservation, if appropriate.

Details relating to purpose, logistics, and personal safety shall be established during discussions between the paleontologist, the environmental inspector, and construction personnel prior to commencement of excavation.

A brief presentation outlining the mitigation program and relevant statutes and presenting examples of local fossils shall be given by the paleontologist at the pre-construction environmental and safety meeting.

Given existing plans for a single construction spread and six pieces of excavation equipment (five backhoes and one ditching machine) operating for three weeks, a single paleontologic monitor shall be on site during all periods during which excavations into paleontologically sensitive geologic units (e.g. Riverbank Formation) are expected. Equipment operators, supervisors, inspectors, and other field personnel shall be required to report to the paleontology monitor any suspected fossil discoveries, but shall not act as substitutes for the designated paleontology monitor.

Excavations into paleontologically sensitive geologic units and extending more than one foot below the pre-existing surface or extending below modern fill, whichever is deeper, shall be visually monitored during the excavation process by a paleontologist with experience in vertebrate fossil monitoring and salvage at construction sites. The paleontologist shall be prepared to properly collect and document any large vertebrate remains and to recognize and appropriately sample and document any sedimentary bodies revealing small vertebrate remains: Large bulk samples may be appropriate. Minimum documentation includes exact location, orientation, depth, and detailed geologic setting of any finds, supplemented with good quality field photographs.

Whenever possible, the paleontologist shall directly observe active backhoe excavations. When two or more backhoes are operating simultaneously at different excavation sites, separate paleontologists shall monitor each excavation site, or active excavations shall not occur simultaneously. Project environmental monitors with a strong paleontology background may be used in addition to a paleontologist with the approval of the CSLC.

During trenching machine excavations, and before placement of pipe segments adjacent to the trench, the paleontologist shall inspect both sides of the trench and both sides of the spoils pile. If fossil specimens are located on the spoils pile, every effort shall be made to locate any portions of the specimen or associated specimens remaining in the trench walls.

Salvage of potentially significant specimens discovered in situ in trench walls or floor or other excavated surfaces shall be conducted by the paleontologist in compliance with all safety regulations and with implementation of all feasible precautions. The on-site safety inspector shall hold final authority to determine whether each proposed salvage operation is consistent with established safety policies at the site. Excavation equipment and operators shall be made available for short periods to remove overburden above in situ specimens, to improve safety conditions during salvage operations, or to aid in transport within the site boundaries of any large salvaged specimens which cannot be safely transported by hand.

The paleontologist shall have authority to halt or redirect excavation operations in the event of discovery of vertebrate, plant, or invertebrate fossils until such time as their probable significance can be assessed and, if potentially significant, appropriate salvage measures have been implemented.

Any potentially significant fossils recovered during the monitoring and salvage phase shall be cleaned, repaired, and hardened to the level required by the repository institution, and donated to that institution. Any collected bulk sediment samples having the potential for small fossil vertebrate remains shall be wet- or dry-screened and processed as necessary for recovery of the included fossils.

Copies of all supporting field records, notes, maps, geologic sections, and photographs shall be submitted to the repository institution in accordance with their policies. Any additional documentation and curation activities requested by the repository institution shall be performed under the mitigation plan.

The paleontologist shall prepare a final report of the mitigation plan, its implementation, and results and submit it to the appropriate parties, institutions, and government agencies.

Costs incurred in implementation of these measures shall be borne by PG&E.

Impact Discussion

The following discusses potential impacts associated with geologic hazards, soils, paleontology, and mineral resources.

Geology and Soils

Soil Settlement

All soil that would be displaced by horizontal directional drilling and hammer borings would be replaced with the proposed pipeline. The development of large subsurface voids and subsequent soil settling due to drilling and boring operations would not be expected. Based on Project requirements in non-structural areas, the trench backfill would be compacted to 85 percent relative compaction using American Society for Testing and Materials Test Method D 1557. The relative compaction of the trench backfill in structural areas, such as at road crossings, would be to 95 percent. Therefore, settlement of trench backfill that could damage structures would not be expected. The potential impact is less than significant (Class III).

Seismically Induced Ground Motion

Installation of the proposed pipeline would not increase the likelihood of liquefaction and dynamic settlement. Where the pipeline would be installed by HDD, the majority of the pipeline would be below the zone subject to liquefaction, which extends down to 50 feet below the ground surface. Where the pipeline would be installed by trenching, the pipeline would be covered with non-liquefiable excavated subsoils that meet PG&E's backfilling requirements. In addition to federal and State codes, regulations, and industry standards for the pipeline design, the CSLC requires that the pipeline design meet the requirements of current seismological engineering standards for seismic resistant design of the pipeline, such as the *Guidelines for the Design of Buried Steel Pipe*, 2001 by American Lifeline Alliance and *Guidelines for the Seismic Design and Assessment of Natural Gas and Liquid Hydrocarbon Pipelines*, 2004 by Pipeline Research Council International, Inc. The CSLC also requires that all engineered structures, including pipeline alignment drawings, profile drawings, buildings and other structures, and other appurtenances and associated facilities, be designed, signed, and stamped by California registered professionals certified to perform such activities in their jurisdiction such as Civil, Structural, Geotechnical, Electrical, and Mechanical Engineering.

Damage to the proposed pipeline would be extremely unlikely, because steel pipelines are ductile and able to stretch, bend, or spread in response to stress. Modern, butt-welded steel pipelines have exhibited excellent performance world-wide during seismic events. Additionally, PG&E's modern (post 1970) welded steel gas transmission lines experienced virtually no damage during the Loma Prieta 7.1 magnitude earthquake in

San Francisco in 1989. It is highly unlikely that structural damage would be caused by seismic activity resulting in an inadvertent or uncontrolled release of methane.

Strong seismic shaking during construction activities could result in failure of open trenches. OSHA regulations for in-trench work and shoring would be required to protect workers from slope instability in trenches. Any necessary enhancements to OSHA-approved shoring would be incorporated into final trench design. Therefore, potential impacts related to seismically induced ground motion would be less than significant (Class III).

Rupture along a Known Earthquake Fault

As discussed in the Regional Faulting portion of Section 4.3.1, Environmental Setting, there are no known active faults or shear zones that cross the proposed pipeline alignment or are present in adjacent areas. Alquist-Priolo Earthquake Fault Zones are not present along the proposed alignment or adjacent areas. Accordingly, there is no potential for ground surface rupture due to faulting. No impacts would occur.

Soil Erosion and Loss of Topsoil

Pipeline construction activities would include clearing, grading, trenching, tunneling and excavation work resulting in soil disturbance and would have the potential to result in erosion and the loss of topsoil. PG&E is proposing to secure a 75-foot-wide temporary use area to install the pipeline in a 42-inch-wide trench. Where necessary, the construction work area would be cleared and graded to provide a relatively level surface for trench-excavating equipment and a sufficiently wide workspace for the passage of heavy construction equipment. These clearing and grading activities would likely be minimal because the proposed pipeline would primarily cross relatively flat agricultural lands.

Pipeline construction activities would use erosion-control techniques following best management practices outlined in PG&E's Water Quality Construction, Best Management Practices Manual and would be coordinated with the appropriate Federal, State, and local agencies. To minimize erosion, PG&E would implement both short and long-term erosion control measures. Temporary erosion controls would be installed immediately following initial soil disturbance as necessary to minimize erosion and contain excavated material within the approved temporary use areas. Soil conditions would be monitored and erosion control measures would be maintained throughout construction until construction is completed and the site is restored in accordance with pre-arranged landowner requirements. This potential impact is considered less than significant (Class III). For additional discussion of erosion-related impacts, see Section 4.4, Hydrology and Water Quality.

Potential Reduction in Agricultural Productivity

Mixing of topsoil with other subsoils can reduce the fertility and productivity of the topsoil. Per the Project Description, prior to trenching and excavations for the horizontal directional drilling and hammer boring, the topsoil would be segregated in accordance with landowner stipulations. This segregation and subsequent replacement of the topsoil would minimize mixing with the subsoils. In agricultural areas the trench backfill will be compacted to a relative compaction of 85 percent based on American Society for Testing and Materials Test Method D 1557. Specifications typically require a relative compaction of 90 percent for compacted fill. The lower relative compaction would minimize the adverse affects of compacted soil on agricultural productivity. The potential impact to the productivity of agricultural topsoils is considered less than significant (Class III).

Project's Effect on Levees

The Cosumnes/Mokelumne River HDD crossing would cross beneath a levee system. Per the Project Description, the depth of the HDD crossing would be a minimum of 60 feet below the bed and levee banks of the Cosumnes and Mokelumne Rivers. Based on the proposed depth of the horizontal drilling and the proposed implementation of a Drilling Plan and Drilling Programs (see Applicant Proposed Measures APM GEO-2 and APM GEO-3) it is extremely unlikely that the river crossings would have any impact on the stability or proper functioning of the levee system. Further, per the proposed Drill Programs, a qualified horizontal drilling inspector would be on site full-time during the drilling operations. The drilling inspector would have the authority to stop the drilling operations if it appears as though damage is occurring to any above-ground appurtenances. Regarding the proposed bridge removal, PG&E has committed to implementing a Bridge Removal Work Plan that would be completed by a registered engineer to ensure bank stability during removal activities along the north bank of the Cosumnes River. The potential impact to any levee or levee system by the project is considered less than significant (Class III).

Project's Effect on Seepage

Seepage problems have been reported to occur in the vicinity of the railroad tracks east of Franklin Road (see Comment Letter 1 in Appendix B). The transport of water seepage into and along trenched sections of the pipeline route could worsen existing seepage or create new conduits if granular trench backfill is used in close proximity to levees. However, PG&E has included construction techniques as part of the proposed Project which would avoid creating a conduit for seepage. As described in Section 2.3.2, New Pipeline Construction Procedures, trench barriers or breakers would be installed before backfilling at specified intervals to prevent water movement along the pipeline. The trench would be backfilled using select excavated subsoils that meet PG&E's backfilling requirements. A moderate level of compaction, 85 percent of maximum density using the American Society for Testing and Materials (ASTM) D-1557 test procedure, would be used to reduce the risk of uplift and to act against seepage. With these backfill techniques, the transport of nuisance water seepage through trench backfill would be less than significant (Class III).

Mineral Resources

The proposed Project area is not located within a known mineral resource area and the Project would not impede access to any identified mineral resources. Therefore, there would be no loss of availability of a known mineral resource that would be of value to the region and the residents of the State. Additionally, upon review of both the Sacramento County General Plan and the San Joaquin County General Plan, there are no recognized mineral resources identified within the proposed Project area. The proposed Project would not result in a loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan, or other land use plan. Therefore, there would be no impacts to mineral resources associated with the proposed Project.

Paleontological Resources

Trenching and other excavation-related activities associated with construction of the proposed Project would disturb a large volume of paleontologically sensitive sediments identified as the Riverbank Formation. The total anticipated length of the trenched portion of the Project would be approximately 39,820 feet. Assuming an average trench depth of 7.5 feet and width of 4 feet, approximately 1,195,000 cubic feet of sensitive sediment would be displaced by Project-related trenching. However, PG&E has committed to implementing a Paleontology Monitoring Program to protect any discovered paleontological resources (see Applicant Proposed Measure APM PAL-1, above). Implementation of APM PAL-1 would ensure that potentially significant impacts would be less than significant (Class III).

4.3.5 Impacts of Alternatives

No Project Alternative

The No Project Alternative would not result in the construction and operation of a natural gas pipeline between the Elk Grove and Thornton Stations. Consequently, there would be no potential for geologic conditions to cause structural damage to a new pipeline, or for a new pipeline to cause damage to soils. In addition, there would be no mechanism to cause impacts to subsurface paleontologic resources. Therefore, the potential impacts to geology, soils, and paleontologic resources described above for the proposed Project would not occur under the No Project Alternative. Similar to the proposed Project, there would be no impacts to mineral resources associated with the No Project Alternative.

Franklin 1 Alternative

This alternative would not differ substantially in length or in the types of pipeline installation techniques that would be used compared to the proposed Project. As a result, potential impacts associated with geologic hazards, soils, and paleontologic resources that would result under the Franklin 1 Alternative would not differ from those described above for the proposed Project. Impacts would be less than significant (Class III). As with the proposed Project, the Franklin 1 Alternative would result in no impacts to mineral resources.

Franklin 2 Alternative

The Franklin 2 Alternative would result in potential impacts that are the same as the Franklin 1 Alternative and the proposed Project. The Franklin 2 Alternative would result in less than significant impacts (Class III). As with the proposed Project, the Franklin 2 Alternative would result in no impacts to mineral resources.

Project without Bridge Replacement Alternative

The Project without Bridge Replacement alternative would not alter any portion of the proposed Project pipeline alignment or the construction methods. Under this alternative, the historic suspension bridge would be left in place. As a result, potential impacts associated with geologic hazards, soils, and paleontologic resources that would result under this alternative would not differ from those described above for the proposed Project. Impacts would be less than significant (Class III). As with the proposed Project, the Project without Bridge Replacement Alternative would not result in any impacts to mineral resources.

4.3.6 Cumulative Projects Impact Analysis

Geology and Soils

The proposed Project would be expected to result in only temporary impacts on near-surface geology and soils. The Project would also not be expected to induce or aggravate landslides or seismic activity in the region. Because any Project impacts related to geology or soils would be highly localized and primarily limited to the duration of construction, cumulative impacts on geology and soils would occur only if another project would be planned for construction at the same time and place as the proposed Project. None of the projects listed in Section 3.4, Cumulative Related Future Projects, meet this condition. The proposed Project would not be cumulatively considerable with respect to impacts associated with geology and/or soils. Cumulative impacts would be less than significant (Class III).

Paleontologic Resources

The accelerating urbanization of the Central Valley and associated infrastructure expansion is progressively rendering paleontologic resources inaccessible. Because potential fossiliferous Pleistocene deposits in the Central Valley typically underlie relatively level areas above major floodplains, which are also areas of high value for development, these deposits are disproportionately threatened. However, most large-scale excavation projects require compliance with State and Federal environmental laws, as discussed above, that require mitigation of potential adverse impacts to paleontologic resources. As a result, the incremental loss of significant paleontologic resources would not be significant or cumulatively considerable. Cumulative impacts would be less than significant (Class III).

Mineral Resources

The proposed Project would not result in any impacts to mineral resources. Therefore, the proposed Project would not be cumulatively considerable from the standpoint of impacts on mineral resources. No cumulative impacts would occur.